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ABSTRACT

This paper advocates the use of independent research projects as a practical means of individualizing science instruction within the framework of a traditional school program. The science program at Model Laboratory School, Eastern Kentucky University, Richmond, Kentucky, is discussed as an example of independent study being an integral part of the science curriculum. In each of the science courses offered in grades 7-12 students have an opportunity to work independently on research projects. This form of instruction achieves its greatest emphasis in the second-level biology course, in which students may elect to take independent research for the entire year if they so desire. Some of the major problems encountered by the student as he develops his project include: difficulty in identifying a reasonable topic; obtaining equipment, chemicals, and other supplies; researching the topic in the library; adequately controlling variables; and persisting with the project through to completion. Despite these difficulties, students involved in this form of independent study usually become highly motivated and enjoy the variety of work and freedom to make their own choices. Literature is cited which indicates increased academic achievement among students involved in research projects as part of the course requirement. (JR)

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INDEPENDENT RESEARCH PROJECTS A PRACTICAL MEANS OF INDIVIDUALIZING INSTRUCTION

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Developing a practical means of individualizing science instruction in a traditional school setting with traditionally oriented students can be a challenging task. A few of the perplexing problems a teacher must overcome in an effort to open his classroom for broader learning experiences, may include the physical plant, prior educational experiences of the students, heavy class loads, large class size and inadequate equipment. One way this can be accomplished, with a minimal realignment of facilities and staff, is to encourage independent research projects as a part of the science curriculum.

Independent research is an integral part of the science curriculum at Model Laboratory School. Students in grades 7-12 have some type of independent research experience built into each science course elected. The depth of the research is of necessity dependent upon their maturity level, however, all students design a research project, collect data and form a conclusion based upon this data. The significance of the actual research is really of little consequence, even though many students at the high school level develop and complete excellent original research projects. The important thing is that they are working in an area of interest, with little if any direction from adults, and are searching out information which can be directly related to the problem at hand. Developing the processes involved in problem solving then, is the primary objective of independent research in our program.

Modern science curricula place much importance on laboratory investigation as a means of learning science. Most programs, however, expect, and very often the sequential nature of the program demands, that all students carry out the same

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investigations, in the same order and hopefully at nearly the same time. Without a doubt, modern science programs are far superior to their textbook predecessors, however, most leave a great deal to be desired if individualization is deemed important in the science classroom.

Some complex considerations regarding independent study, as a means of individualization, which have often discouraged teacher adoption include the time allotment for project work, evaluation of student progress during independent study and teacher/student involvement during class time. Most of these difficulties can be overcome if the teacher adopts a philosophy which encourages students to work without direct guidance utilizing sufficient laboratory materials to develop the concepts inherent in each discipline.

Independent research project work at Model Laboratory School is begun in the 7th grade (fig. 1). The project requirement at this level is stated as: "Develop a hypothesis regarding some observed phenomenon, set up an experimental procedure to prove or disprove the hypothesis, collect data to support the hypothesis and form a conclusion based on this data." A short paper describing the project culminates the assignment with the additional option, if the student is interested, of preparing a graphic display for science fair competition. Research at this level is rarely original, however, some of the results obtained are quite significant and always extremely meaningful to the investigator.

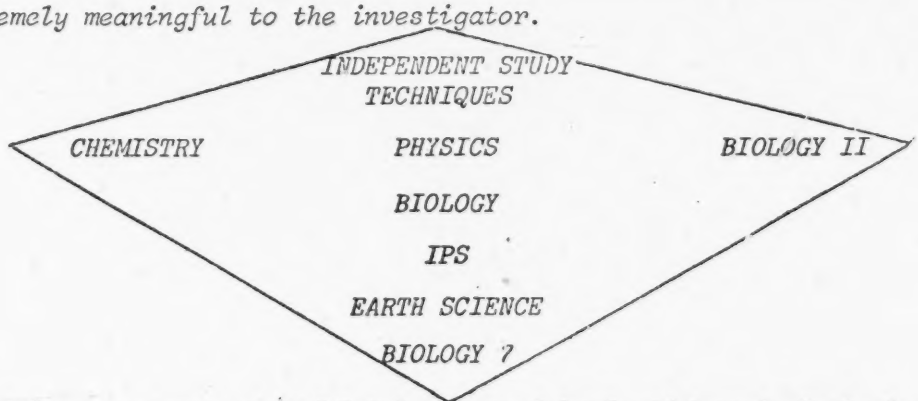

Figure 1. Science program at Model Laboratory School, Richmond, Kentucky, illustrating the interrelationship of independent study to the disciplines.

The research assignments are similar in grades 8 and 9 with the major emphasis in the areas of earth and physical science.

Most of the project work is completed outside of class time in grades 7-9, although, a constant rhetoric is maintained with each student as to his progress. Occasionally, some class time is devoted to independent research study or students may request the use of class time to carry out specific procedures. Research completed at a community high school in Illinois indicates that students who were expected to complete a research project as part of the course requirement scored significantly higher than their non-research counterparts on standardized biology tests at the end of the school year.[1] This data indicates that course time can be spent on independent studies without jeopardizing the student's knowledge of important science concepts.

Extensive research projects are carried out in grades 10-12 as part of the course requirements in general biology, chemistry, physics, and biology II. In the biology II course, the research effort comprises the major portion, and possibly the entire year long experience if the student desires. This research involves a thorough search of the literature (utilizing Eastern Kentucky University's John C. Crabbe Library Facility), establishing a hypothesis, developing the experimental procedure, collecting data and forming a conclusion. The final product is a properly written scientific research paper with a complete bibliography of literature citations. There is no definite "scientific method" taught in this activity and each student develops his own experimental techniques.

The general procedure used in the biology II course will be utilized to illustrate how independent research study may be used to help individualize a science class. The students all begin the course with the same introduction, a 3-4 week

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[1] John B. Simmons, William J. Davis, Gary C. Ramseyer and James J. Johnson, "Independent Study Methods and the Gifted Biology Student," American Biology Teacher, 33 (October, 1971) 416-18.

library research experience in which the primary objective is a complete familiarization with this resource center so that the student can pursue his topic effeciently. It is also hoped that during this period, a project idea can be generated and the initial literature search completed.

At the end of this time, a "bidding system" is instituted by which the student may elect to work on his research during class time or select a particular lab unit (structured laboratory activity) for completion during the "bid period" of usually 1-3 weeks (fig. 2). Since students are evaluated on the amount of work each individual accomplished, it is not essential, or even desirable, that every student

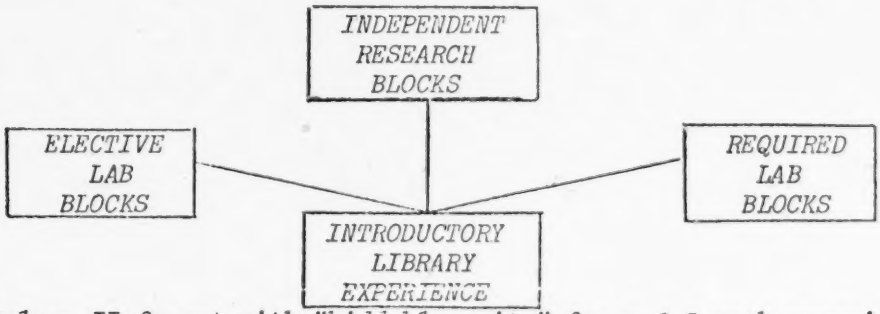

Figure 2. Biology II format with "biddable units" for a 1-3 week experience.

complete every unit. Students are encouraged to think carefully of their research requirements so that valuable class time is not wasted due to poor planning. The above procedure essentially assures that each student is pursuing a specific goal at all times. Evaluation includes student/teacher conferences, student self-evaluation, casual observation and assessment of the work accomplished in any 9 week session.

Some of the major problems the student encounters in developing his independent research project are difficulty in identifying a reasonable topic, obtaining equipment, chemicals, etc., researching the topic in the library, adequately controlling variables and finally, just seeing the project through to completion. There are ways the teacher can help eliminate these provocations and subtly prevent overt discouragement during the research period.

High school students usually have a real struggle trying to identify a project topic challenging enough yet within the scope of possible completion in the school's laboratory. The project topic hopefully will be generated from the student's own personal experiences, his reading or previous science coursework. Sometimes, the student will come to class with the project well mind the first day of school, however, this is by far the exception. The resident idea usually has to be refined, and a ready resource shelf of Scientific Americans, Science World, professional journals, science supply company bulletins and governmental research documents, to list a few, will aid the student in this process. Almost all high schools are within easy driving distance of a wealth of resources in the regional universities and junior colleges. College professors are usually more than willing to serve as resource persons and arrangements can be made to utilize their library facilities. Technical assistance is also available for equipment design and obtaining data which requires elaborate and expensive instrumentation.

Once the student has identified the problem area, his related literature search begins. This aspect of independent study varies greatly at this level and most students are reluctant to spend more than the bare minimum required to get their research off the ground. Since most problems are not for publication as original research and the problem solving process is the important product of the project, literature review has only limited value and students should not be forced into over-extensive and sometimes fruitless, in their view point, literature searches at the offset of their research work. As the study develops, they will spend increasingly long hours in the library.

Controlling variables and collecting accurate date is often a distinct problem in the first research attempts. These two facets are important processes to be developed and adequate teacher time must be spent in assisting students who are

not sensitized to the value of either. Remedial work in measurement, quantifying observations and preciseness is often necessary.

The teacher and student must maintain constant contact throughout the independent study for maximum success. A "checkpoint" system can be maintained to record progress and keep the student involved. Dates when the topic, preliminary outline, progess reports and final writeup are due should be made available at the beginning of the work and adhered to throughout the year. This check-point system may also include state, regional and national science activities which the student may wish to participate in.

Students who have been involved in independent study usually become highly motivated science students. Some studies have indicated that even though science learning was not necessarily increased, students were more involved in the course and enjoyed the variety of work and the freedom to make their own choices. The student's participation in extra curricular science activities such as science club, the Junior Academy of Science and Junior Science Symposia add even greater depth to his educational experience. The nature of these activities, involving writing the paper, paper presentation and social contacts are important enough to warrent their encouragement.

Independent research study at the secondary level will add a significant individualization factor to the total science program. The student is allowed to pursue a topic of interest, he is developing the processes of science and probably most important of all, he usually becomes highly motivated in his science coursework.

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[2]Paul W. Richard, "Experimental Individualized BSCS Biology," Science Teacher, 36 (February, 1969) p. 53-4.

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